IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

D. Remarks

Rejection of Claims 1-3, 5, 7 and 9-10 Under 35 U.S.C. §103(a), based on U.S. Patent No. 6,100,202 (*Lin et al.*) in view of U.S. Patent No. 6,541,394 (*Chen et al.*).

The invention of claim 1 is directed to a method that includes varying a dopant supply rate for a doped insulating layer according to a variation in temperature of a substrate on which the doped insulating layer is formed. Varying the dopant supply rate includes increasing the dopant supply rate as the substrate temperature increases.

As is well known, to establish a prima facie case of obviousness, a rejection must meet three basic criteria. First, there must be some suggestion or motivation to modify a reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference(s) must teach or suggest all claim limitations.

The first reference *Lin et al.* never shows "increasing the dopant supply rate", as recited in claim 1. *Lin et al.* is directed to a "pre-deposition" stabilization method for forming a doped silicate glass layer. *Lin et al.* provides numerous examples of forming a doped silicate glass layers, however none of these examples shows increasing a dopant supply rate. Further, the examples teach away from Applicants' claim 1 limitations, by only teaching no variation in dopant supply rate, or decreasing dopant supply rate. The various examples will now be discussed in order of appearance in the reference.

The general method of *Lin et al.* describes a method that includes (1) a pre-deposition stabilization process step and (2) a doped silicate glass dielectric formation step. The pre-deposition stabilization is intentionally undoped and thus cannot show or suggest Applicants' claim 1 limitations:

> [A] pre-deposition stabilization process step where the substrate is stabilized with respect to a first flow of a silicon source material *absent a dopant source material.*[1]

The formation of the doped silicate glass does provide a dopant source, however, the supply rate is never varied, let alone increased:

[1] *Lin et al.*, Col. 5, Lines 61-62, emphasis added.

> Subsequent to the pre-deposition stabilization process step, the doped silicate glass dielectric layer is formed employing a second flow of the silicon source material, a flow of an oxidant source material and the flow of the dopant source material.[2]

The above excerpt only describes a change in flow of a silicon source material (by indicating a second flow), and describes but one flow for the dopant source material. Accordingly, this first example does not show any variation in dopant supply rate.

Lin et al. continues with a more detailed, second example. However, this example shows no variation in dopant supply rate. In particular, *Lin et al.* describes the formation of a doped pre-metal dielectric (PMD) layer 44 formed over an undoped PMD layer 40. However, in forming PMD layer 44, a dopant supply is never varied.

> [P]re-metal dielectric (PMD) layer 44 is preferably formed through an... SACVD... or... APCVD... method. Either... two methods employs:... (3) the flow of the dopant source material which preferably includes both a boron dopant source material and a phosphorus dopant source material.[3]

Particular ranges are given for <u>the flow</u> of dopant source materials[4], but <u>variation</u> or <u>an increasing supply rate</u> are not shown or suggested by this example. Thus, this example does not show the dopant supply rate limitations of claim 1, either.

A final, detailed example is described in *Lin et al.* However, this final example would appear to teach away from Applicants' increasing supply rate limitations, as it explicitly teaches <u>decreasing</u> a dopant flow rate. In particular, the example teaches first and second deposition steps. The first deposition step indicates <u>one</u> flow rate for a boron dopant source and first flow rate for a phosphorous dopant source.

> The first deposition step employed:... (4) a triethyl borane flow at about 193...

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[2] *Lin et al.*, Col. 5, Lines 63-67.
[3] *Lin et al.*, Col. 9, Lines 23-27.
[4] See *Lin et al.*, Col. 10, Lines 11-13.

> sccm… (5) a triethyl phosphite flow at about 50… sccm…[5]

The second deposition step maintains the same flow rates as the first deposition step, but <u>decreases</u> the flow rate of the phosphorous dopant source.

> The second deposition step employed materials and flows otherwise equivalent to those employed within the first deposition step, with the exception that the triethyl phosphite flow was *reduced* to about 34… sccm…[6]

Applicants' believe all of the above demonstrates that the reference *Lin et al.* does not show or suggest "increasing the dopant supply rate" as recited in claim 1.

The remaining reference *Chen et al.* provides no teachings regarding doped insulating layers, thus cannot show or suggest Applicants' dopant supply rate limitations.

Because the cited combination of references does not show all limitations of a claim 1, a prima facie case of obvious cannot have been established, and this ground for rejection is traversed.

In addition or alternatively, there can be no motivation to combine *Chen et al.* with *Lin et al.*, as the reference teaches away from such a combination. As noted above, *Lin et al.* provides teachings regarding a pre-metal dielectric layer that may include a doped portion. In contrast *Chen et al.* is directed to growing a high quality oxide layer. *Lin et al.* repeatedly emphasizes that dopants in such a film are <u>undesirable</u>, as such dopants can outdiffuse into a transistor channel region:

> The introduction of nitrogen atoms into the gate dielectric may *suppress diffusion of boron atoms* from heavily doped p+ polycrystalline silicon gate electrodes…[7]

> Silicon dioxide is not a good *diffusion barrier for gate electrode dopants*, such as boron.[8]

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[5] *Lin et al.*, Col. 15, Lines 12-22.
[6] *Lin et al.*, Col. 15, Lines 22-26, emphasis added.
[7] *Chen et al.*, Col. 1, Lines 50-53, emphasis added.
[8] *Chen et al.*, Col. 2, Lines 12-13, emphasis added.

> The first oxide portion 31 may further comprise an uppermost nitride portion, for example, not shown. The nitride portion serves to *block dopant penetration in to the oxide layer 30* as will be readily understood by those skilled in the art.[9]

The above is believed to clearly show that *Chen et al.* directed to blocking dopants from entering a gate oxide layer, thus teaches away from forming a doped oxide layer. Accordingly, the motivation for combining *Lin et al.* in view of *Chen et al.*, necessary to establish a prima facie case of obviousness, is believed to be lacking.

Dependent claim 3 includes additional limitations not shown or suggested by the cited reference. Claim 3 recites that different dopant supply rates are provided for different time periods. Further, the different time periods include periods of the <u>same length</u>. As understood from the above arguments for claim 1, there is only one example in *Lin et al.* that shows different flow rates for a phosphorous dopant source. The example teaches first and second deposition steps. However, such deposition steps are for time periods of <u>different lengths</u>:

> The first deposition step employed... for a time period of about *2 seconds*. The second deposition step employed... for a time period of about *180 seconds...*[10]

Applicants' believe the above disparity in time period lengths (2 seconds versus 180 seconds) clearly teaches away from the "periods of same length" limitation set forth in claim 3.

For this additional reason, a prima facie case is not believed to have been established for claim 3.

<u>Rejection of Claim 4 Under 35 U.S.C. §103(a), based on *Lin et al.* in view of *Chen et al.* and further in view of U.S. Patent No. 6,355,581 (*Vassiliev et al.*).</u>

To the extent that this ground for rejection relies on the combination of *Lin et al.* in view of *Chen et al.*, the comments set forth above for claim 1 are incorporated by reference herein.

[9] *Chen et al.*, Col. 2, Lines 50-53, emphasis added.
[10] *Lin et al.*, Col. 15, Lines 12-28, emphasis added.

Namely, the combination does not show or suggest all limitations of claim 1 and/or motivation for combining *Lin et al.* in view of *Chen et al.* is believed to be lacking.

Rejection of Claim 8 Under 35 U.S.C. §103(a), based on *Lin et al.* in view of *Chen et al.* and further in view of U.S. Patent No. 4,376,672 (*Wang et al.*).

To the extent that this ground for rejection relies on the combination of *Lin et al.* in view of *Chen et al.*, the comments set forth above for claim 1 are incorporated by reference herein. Namely, the combination does not show or suggest all limitations of claim 1 and/or motivation for combining *Lin et al.* in view of *Chen et al.* is believed to be lacking.

Rejection of Claims 11, 13-16 and 18-19 Under 35 U.S.C. §103(a), based on *Lin et al.*, U.S. Patent No. 6,251,546 (*Barnes et al.*) in view of *Wang et al.*).

The invention of claim 11 is directed to a method that includes compensating for a temperature dependent gradient in a doped insulating film. The doped insulating film comprises silicon oxide with a phosphorous concentration greater than about 7% by weight. Such a compensating step includes varying a dopant supply rate as the doped insulating film is formed.

As emphasized above, Applicants' claim 11 invention includes compensating for a temperature dependent gradient in a doped insulating film comprising silicon dioxide. Such a limitation is not shown or suggested by the cited combination of references.

It is admitted that *Lin et al.* does not show compensating for a temperature dependent gradient.[11] However, such a limitation is not shown in the remaining references, either.

While Applicants believe that the term compensate is understood, one definition is set forth below to emphasize the difference between the claim language and the cited references.

Main Entry: **com pen sate**

1 : to be equivalent to **:** COUNTERBALANCE

2 : to make an appropriate and usually counterbalancing payment to

3 a : to provide with means of counteracting variation **b :** to neutralize the effect of (variations)[12]

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[11] See the Office Action, dated 8/29/2003, Page 5, Lines 10-11.

[12] Merriam-Webster On-Line Dictionary, Internet: http://www.m-w.com.

The second reference relied upon, *Barnes et al.*, does not show compensating for a gradient by varying a dopant supply rate. *Barnes et al.* is directed to a method of making a fluoro-organosilicate layer ($SiC_aF_bH_c$). This reference teaches that as deposition temperature increases, a resulting dielectric constant of the fluoro-organosilicate layer decreases. In addition, as the fluorine and/or carbon concentration increases, the dielectric constant of the fluoro-organosilicate layer decreases.[13] That is, the reference identifies a relationship between reaction temperature and dielectric constant. However, the reference never shows or suggests a compensating action in response to such a relationship. In fact, *Barnes et al.* seems to indicate the opposite: maintaining a single temperature to arrive at one desired dielectric constant:

> The dielectric constant of the fluoro-organosilicate layer is tunable, in that it can be varied in a range between about 2.5 to about 3.5 as a function of *the* reaction temperature.[14]

In addition or alternatively, there is no motivation for combining the teachings of *Barnes et al.* with that of *Lin et al.* (and *Wang et al.*), as proposed. As is well established, if a proposed modification or combination would change the principle operation of the prior art invention being modified, the teachings of the references are not sufficient to render the claims prima facie obvious, as there is no suggestion or motivation to make the proposed modification.

Modifying *Lin et al.* in view of *Barnes et al.* would change the principle operation of *Lin et al.* *Lin et al.*, as described above with reference to claim 1, is directed to a stabilization method for a doped silicate glass layer. In sharp contrast, *Barnes et al.* is unrelated to silicate glass layers, but instead is directed to fluoro-organosilicate layers ($SiC_aF_bH_c$), which are not silicate glass layers. Said in another way, modifying *Lin et al.* in view of *Barnes et al.* would have to include changing the basic underlying material of *Lin et al.* from silicate glass to a fluoro-organosilicate layer ($SiC_aF_bH_c$). This is a fundamental departure from the basic reference, and thus believed to be a change in principle operation.

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[13] See *Barnes et al.*, Col. 6, Lines 37-53.

[14] *Barnes et al.*, Col. 6, Lines 39-42, emphasis added.

For all of these reasons, Applicants' believe a prima facie case of obviousness has not been established for claim 11, and this ground for rejection is traversed.

Claim 19, which depends from claim 11, is believed to include additional features patentable over the cited references. Claim 19 recites that varying a dopant supply rate includes closed loop control of dopant source supply rate with active temperature feedback from a reaction chamber. Such a limitation is not shown in the cited references. Neither *Lin et al.* nor *Wang et al.* provides teachings regarding temperature control of a chamber, thus cannot show or suggest the limitations of claim 19.

Barnes et al. describes forming a fluoro-organosilicate layer in a temperature control chamber. However, the reference never describes controlling a dopant source supply rate with active temperature feedback. The various teachings of the reference will now be discussed in detail to demonstrate this point.

Barnes et al. includes a temperature sensor and feedback loop. However, such features are utilized to maintain a constant temperature and are never utilized to vary the supply rate of any material, let alone a dopant source:

> [T]emperature sensor 172... is also embedded... to monitor the temperature of the pedestal 150 in a conventional manner. The measured temperature is used in a feedback loop to control the power supply 16 for the heating element 170, such that *the wafer temperature can be maintained or controlled at a desired temperature* which is suitable for the particular process application...[15]

> By properly adjusting the current supplied to the heating element 170, the wafer 190 and the pedestal 150 can be *maintained at a relatively constant temperature* during film deposition. This is accomplished by a feedback control loop, in which the temperature of the pedestal 150 is continuously monitored by a thermocouple 172... This information is transmitted to the control unit 110... which responds by sending the necessary signals to the heater power supply.[16]

[15] *Barnes et al.*, Col. 3, Lines 16-23, emphasis added.
[16] *Barnes et al.*, Col. 4, Lines 12-21, emphasis added.

From the above it is clear that this portion of the reference teaches feedback to maintain (i.e., not vary) a temperature. Further, the feedback remains unrelated to dopant supply rate.

The above is believed to clearly show that *Barnes et al.* uses temperature feedback to maintain a temperature, and not to vary a dopant supply rate.

For these reasons, the combination of reference is not believed to show or suggest all limitations of claim 19. Accordingly, the rejection of this claim is also traversed.

The present claims 1-5, 7-11, and 13-19 are believed to be in allowable form. It is respectfully requested that the application be forwarded for allowance and issue.

Respectfully Submitted,

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